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Report of the Television Advisory Committee 1967

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FOREWORD

Postmaster General,

During the course of our study of the method and timing of changing over the definition standard on which B.B.C.–1 and the services of the Independent Television Authority are broadcast, from 405 to 625 lines, we reported to you and your predecessors from time to time as occasion required. The study was brought to a conclusion with the recommendations made to you in January 1967; namely that an early start should be made on the change of standards, using the duplication method, and that colour should be introduced into the 625-line transmissions of B.B.C.–1 and of the Independent Television Authority.

On 15th February 1967 you announced that the Government had decided to accept the recommendations.

It has seemed to us that it would be useful to bring together in a single record the background to these recommendations and the essential material contained in the reports we have prepared in the course of this study; and it is as such a record that the attached account, which has been approved by the Television Advisory Committee, is presented to you.

LORD JACKSON OF BURNLEY
Chairman, Television Advisory Committee.

INTRODUCTION

1. It may be useful at the outset to consider briefly the function of the line definition standard in the composition of a television picture and to trace the steps which led to the use of the existing 405-line standard. It might also prove helpful to relate the position in the United Kingdom to the international context.

Importance of the line definition standard

2. A television picture is constructed by varying the brightness of a spot that is made to scan across the face of a cathode-ray tube. The resolution of a television picture in the vertical direction is determined by the number of horizontal scanning lines per picture and an increase in the number of lines therefore improves the vertical definition. An important subjective effect of increasing the number of lines is to reduce the visibility of the line structure. The great advantage of a higher line standard is that it makes possible the use of larger screens for the television picture. A reduction in the visibility of the scanning lines enables viewers to sit nearer to the television screen.

3. However, when a change is made in the number of scanning lines, it is also necessary to change the bandwidth of the transmitted signal. The 405-line signal can be adequately transmitted in a 5 MHz channel whereas, as stated in the " Report of the Television Advisory Committee 1960 " (paragraph 17), it was agreed that 625-line signals should be transmitted in channels 8 MHz wide.

4. In short, the advantage of the higher line standard is improved vertical definition and reduced line visibility and the penalty is the requirement of a wider frequency band.

Why existing services use 405 lines

5. Experimental television broadcasts started in this country as early as the autumn of 1929. They were made by the Baird Company with facilities provided by the British Broadcasting Corporation. In August 1932 the B.B.C. afforded facilities to Baird Television Limited for public experimental transmissions from their London station at Brookmans Park. A frequency of 754 kHz (a wavelength of 398 metres) was used for the sound signal and a frequency of 1167 kHz (261 metres) for the vision signal. These transmissions were made on a definition standard of only thirty lines.

6. In May 1934 a Committee was appointed under the Chairmanship of Lord Selsdon to consider the development of television. This Committee pointed out that any pictures built up with a structure of the order of thirty lines were very coarse in texture. Little detail could be given and generally speaking the pictures were only suitable for the presentation of " close-ups "—e.g. the head and shoulders of a speaker—and the quality of reproduction left much to be desired. The Committee considered that better definition was essential to increase the utility and entertainment value of television. They recognised that the degree of definition regarded as essential was a matter of opinion but on the evidence they had received and on their own observations they concluded that a picture should be of not less than 240 lines. To attain such a degree of definition the use of very high frequencies is required but the Committee foresaw no difficulty in making these available in the frequency spectrum

between 30 MHz and 100 MHz. They recommended that a public television service of high definition should be established, operated by the B.B.C. (See report of the Television Committee 1935 Cmnd. 4793.)

7. The Government accepted the recommendations of the Committee and a regular public television service was inaugurated in November 1936 at the B.B.C. station at Alexandra Palace. It was the first public high-definition service in the world. Two systems were used alternately, the Baird and the Marconi-E.M.I., until February 1937 when it was decided to adopt the Marconi-E.M.I. system. This system used a definition standard of 405 lines interlaced. Plans to extend the service had to be abandoned with the advent of war and the television service was closed down on 1st September 1939.

8. In September 1943 a Committee under the Chairmanship of Lord Hankey was appointed " to prepare plans for the reinstatement and development of the television service after the war." The Committee reported in December 1944 (Report of the Television Committee 1943). This Committee considered that the 405-line standard of definition gave a very satisfactory picture for a size of about 8 ins. x 10 ins. They concluded that the right course in the existing circumstances was not to defer the opening of the television service to give an opportunity of incorporating fundamental improvements in the system, but to re-open the television service on the basis of the 405-line system. Their reasons were that:

(*a*) with transmission of greater efficiency and the use of receivers of better design and quality the good entertainment value of the 1939 service on 405 lines would soon be surpassed;

(*b*) a good deal of research and development taking a period of some years would be required before a markedly improved service, having a higher definition, could be put into operation; and to leave a gap of some years without any television service would have damped interest and seriously retarded commercial development of the television industry;

(*c*) the re-establishment of a television service as soon as possible after the war was important from the point of view of preventing the dispersal of the highly specialised staff;

(*d*) it was very desirable that, before the introduction of a new and improved system which would involve novel problems, the operating authority should have an opportunity with the 405-line system to consolidate and develop its previous experience;

(*e*) it was most important that there should be no avoidable delay in re-starting the television service if the United Kingdom was to hold a leading position in the television field.

They also concluded that the extension of television to other parts of the country should be planned on the basis of the old system but that the actual scope of extension should be kept under review. The London television service was re-opened by the British Broadcasting Corporation on 7th June 1946.

The international position

9. During the war television had been started in the U.S.A., initially on 441 lines but soon changed to 525 lines at 30 pictures per second, a scanning frequency related to that country's 60 Hz power supply mains frequency, and

using a video frequency bandwidth of 4 MHz. After the war the French, who had initially used a 455-line standard, decided to adopt a higher standard of definition for their television service and chose an 819-line system. After considerable international discussion most of the other European countries, in both Western and Eastern Europe, opted, in 1953, for 625 lines.

U.K. DECISION TO ADOPT THE 625-LINE STANDARD

10. The B.B.C. television service which had opened in 1946 in the London area was subsequently extended to other parts of the U.K. and within ten years was available to some 97 per cent. of the total population. In 1956 there were 15 B.B.C. television transmitting stations operating on very high frequencies (VHF) in Band I (41–68 MHz) of that part of the frequency spectrum allocated to broadcasting. Broadcasting Band II (87·5–100 MHz) was in use for VHF sound broadcasting and the new service of the Independent Television Authority which began in 1955 was accommodated in broadcasting Band III (174–216 MHz). Appendix 4 deals more fully with the question of frequencies used for television broadcasting and the population coverage attained by the various services. At the time of the commencement of our improved television service in 1936 the 405-line standard was called " high " definition. By 1960, however, it was the lowest definition used for any public television broadcasting service in the world.

Television Advisory Committee

11. In 1956 the Television Advisory Committee was asked to say:

(*a*) whether the existing 405-line standard was likely to remain adequate for all purposes for the next 25 years; and

(*b*) whether there was any reason why the United Kingdom should not adopt 625 lines for broadcasting at ultra high frequencies in Band IV (470–582 MHz) and Band V (614–854 MHz) in this country if it were recommended by the international Radio Consultative Committee (C.C.I.R.) as the European standard.

Studies were made of propagation in Bands IV and V and large-scale field trials were held to assess their potentialities for television broadcasting and to make a comparison of 405-line and 625-line monochrome transmission in these bands. (See B.B.C. Report " Television Field Trials of 405-line and 625-line systems in the UHF and VHF Bands 1957–8 "). These field trials involved the subjective assessment of picture quality both in the home and in mobile laboratories. In March 1959 the Television Advisory Committee recommended that the United Kingdom delegation to the IXth Plenary Assembly of the International Radio Consultative Committee should be briefed that, " in the interests of frequency planning, the U.K. would adopt an 8 MHz channel in Bands IV and V if Europe generally adopts this." (Report of the Television Advisory Committee 1960, paragraph 7.) At the meeting held at Los Angeles in April 1959, all the major European countries concerned stated that they were prepared to use 8 MHz channelling in Bands IV and V, and a colour sub-carrier of 4·43 MHz, to achieve a uniform arrangement of channels in those bands. At the European VHF/UHF Broadcasting Conference held at Stockholm in 1961, 8 MHz-wide frequency channels for use with the 625-line standard were adopted in Bands IV and V for use throughout Europe (Annex 2 of Final Acts of the European VHF/UHF Broadcasting Conference, Stockholm 1961).

12. The report of the Television Advisory Committee was published in 1960. It concluded that:

(*a*) The existing 405-line standards would not be adequate for all purposes for the next 25 years;

(*b*) 625-line standards making full use of an 8 MHz channel would give a definite improvement in picture quality over that provided on 405-line standards, particularly with larger pictures (and the tendency over the years had been for screen sizes to increase);

(*c*) the maintenance of 405-line operation would show the United Kingdom to a disadvantage in Eurovision as conversion to a higher line standard degraded picture quality;

(*d*) 625-line operation with the use of an 8 MHz channel would ease the problem of channel sharing with neighbouring countries.

13. The report pointed out that the bringing into use of Bands IV and V would offer the last opportunity the U.K. would have of changing its line standard. If 405-line standards were introduced into Bands IV and V, the U.K. would be committed to those standards indefinitely. On the other hand, if 625-line standards were adopted for the higher bands, then eventually they would need to be introduced into Bands I and III in order to achieve a single standard throughout. The Committee considered that such a changeover was capable of achievement given a long-term plan and with co-operation from all concerned.

14. The Committee also considered the desirability of an even higher line standard. But the higher the standard, the wider the frequency channel required to exploit the full potentialities of the standard and the smaller the number of possible programmes within the available bands. It was considered that the 625-line standard with a total channel width of 8 MHz represented the best compromise and was the only one likely to be acceptable in Europe as a common standard in Bands IV and V.

The Pilkington Committee

15. The 1960 Report of the Television Advisory Committee was considered by the Committee on Broadcasting set up in that year under the Chairmanship of Sir Harry Pilkington to advise on the future of the broadcasting services in the United Kingdom. The Pilkington Committee sought to determine where the balance of long-term advantage lay and weighed the non-technical factors involved in changing the line standard. The major disadvantage of introducing the 625-line standard in Bands I and III was that it would limit the use of these bands to only two television programmes of near national coverage. With the 405-line standard there was a possibility of accommodating in them a third programme of some 95 per cent. coverage. The Committee considered that the loss of this programme would not by itself outweigh the advantages of a change to the 625-line standard. A further factor considered, was the possibly increased costs of transmitting and receiving on the 625-line standard compared with the 405-line standard. However, such increases both to the viewer and to the broadcaster were found not to be significant. They would in any case be more than offset by the improved export opportunities which the adoption

of a 625-line standard would offer. Apart from the fact that it would be easier to export programmes to Europe, the adoption of an international common standard would also help manufacturers of transmitting and receiving equipment to compete more readily in overseas markets.

16. The conclusion of the Pilkington Committee was that the short-term difficulties and disadvantages of changeover did not outweigh the long-term advantage to be derived from the adoption of the 625-line standard throughout the television system and the Committee recommended that the standard be changed from 405 to 625 lines (Report of the Committee on Broadcasting 1960, Cmnd. 1753, paragraph 784). The Government of the day accepted the recommendation and in its White Paper (Cmnd. 1770) stated " The Government has decided that new programmes in UHF should be on 625 lines from the start " (paragraph 43) but that " The present services will continue on 405 lines for some considerable time to come. It would be wrong, however, to continue these programmes indefinitely on technically inferior standards and in due course, therefore, these too should be changed over to 625 lines " (paragraph 44).

IMPLICATIONS OF THE DECISION TO ADOPT 625 LINES

Monochrome television

17. The decision taken in 1962 to adopt the 625-line standard for all television meant ideally that nothing should be done to extend the use of the VHF 405-line services. A rigid insistence on this proposition would, of course, have denied many people television for many years; and in fact the coverage obtained by the 405-line services has been extended since that date. However, the new programme of B.B.C.-2 on UHF was provided on the higher 625-line standard from the outset. The operation of television services on two different line standards posed a problem for the receiver industry, which quickly changed over to the production of dual-standard sets. The problem is still with us, and the only solution is the speedy adoption of a single line standard in spite of the difficulties involved in such an exercise.

Colour television

18. The decision on line standards had important implications for policy on colour television. The Television Advisory Committee in its 1960 Report concluded that colour should only be introduced using the line standards to be adopted ultimately for monochrome transmission, and therefore any decision with regard to the introduction of colour had to follow a decision on line standards. The Pilkington Committee, without specifying any particular system of transmission, recommended the introduction of a compatible service of colour television on the 625-line standard. We cannot do better than recall their own explanation of the reasons (Cmnd. 1753, paragraph 791). " We make it a condition of our recommendation that the service should be on 625 lines. We recognise that this means that no part of the country is likely to have a colour service until UHF transmissions are available to it, but our reasons are these. First, cost: it would be wasteful if the broadcasting authorities and the public equipped themselves for 405-line transmission and reception if this were to become obsolete in a few years. Second, the efforts of the

broadcasting authorities should be concentrated as far as possible on developing 625-line services. Third, the public should be given every reason for expecting the changeover: a decision to develop a 405-line colour service would raise justifiable doubts." This view was accepted by the Government of the day.

19. In August 1965 the Committee was asked by the Postmaster General to look again at this policy when it was considering what system of colour television it should recommend for use in the United Kingdom. The Committee's Technical Sub-Committee reported that high quality colour pictures could be reproduced on the 625-line standard and that the compatible monochrome reception would also be of an acceptable quality but that without further tests it was not possible to say at that time whether 405-line colour transmissions would be acceptable and whether they would provide an acceptable compatible monochrome picture. The manufacturers gave as their assessment that television sets designed to receive colour on both line standards would cost significantly more (7–10 per cent.) than sets designed for 625-line colour only. There was also the fear that dual standard sets would be so complex and unreliable as to jeopardise the success of a colour service. A further factor was the problem of interference. The 405-line transmissions in VHF Band I are particularly liable to suffer from continental interference, and a level of interference tolerable in a monochrome service would be quite unacceptable in a colour service. The problem of interference is discussed more fully in Appendix 5.

20. The Committee recognised that a decision to confine colour to 625 lines meant that the I.T.A., which had not been given the opportunity to operate in the UHF bands, would face the possibility of transmitting indefinitely in black and white only and would put the Authority at a serious disadvantage in an important new development. All the other members of the Committee viewed with sympathy the representations made by the I.T.A. and they noted that the position would be largely redressed if the Government were to decide to authorise a second independent television channel in UHF. In December 1965 the Committee reaffirmed (but with the I.T.A. dissenting) that a colour service should be introduced on the 625-line standard only. At the same time the Committee unanimously recommended to the Postmaster General that for colour on 625 lines the PAL system should be adopted. The reasons for this recommendation and a brief comparison of the main colour television systems are given in Appendix 3.

Difficulties in fully realising the advantages of the 625-line standard

21. At the same time as the higher line standard was introduced for B.B.C.–2, the method of transmitting the sound, the sense of the vision modulation and the frequency band in which the television signals were received were also changed as compared with the VHF 405-line system. A technical comparison of the two standards is given in Appendix 4. The dual standard receiver, required to cope with both these line standards, is necessarily more complex, and, therefore, more costly than a receiver designed for a single line standard; at the same time, because its design is a compromise, it tends not to display to full advantage, the higher quality of the picture transmitted on the 625-line standard. Only if all programmes were transmitted on the higher standard would the full advantage both in picture quality and economy of receiver design, be realised.

CHANGEOVER METHODS

22. In 1962, when the Government of the day announced its decision to adopt the 625-line standard, it recognised that the decision raised " a complicated technical issue as to the best method of changeover from 405 to 625 lines " (Cmnd. 1770, paragraph 44).

23. The Committee has, together with its Technical Sub-Committee and various Working Parties, studied in detail since 1959 many suggested methods of changeover in the VHF bands (Bands I and III). It was thought possible at one time that the change could be made by methods not involving the use of any frequency bandwidth outside the existing width of these bands. These have been called " switch-over " or " overnight changeover " methods. Alternatively consideration was given to methods involving duplicate transmission on 625 lines in the UHF bands (Bands IV and V) of all the programmes transmitted on 405 lines in the VHF bands and the eventual closing down of these 405-line services, so leaving frequency space available in the VHF bands for the introduction of new 625-line services. These have been called " duplication " methods.

Problems of Overnight Switchover

24. The use of the total frequency spectrum at present available for television broadcasting is shown in Appendix 5. At present all thirteen of the 405-line channels available are used to provide national coverage for the B.B.C.–1 and I.T.A. programmes. The original frequency plan allowed for more than two television programmes to be broadcast in the VHF bands and therefore the existing VHF channels are not being used to the greatest efficiency. Nevertheless because of the wider channel bandwidth required for the transmission of 625-line signals (cf. paragraph 3 above), it would not be possible to provide full national coverage for two television programmes in the eight channels that would be available for 625-line working in the existing space in the VHF bands allocated to television broadcasting.

25. If 405- and 625-line services were transmitted simultaneously in the same frequency band interference would be caused to reception. It is therefore not possible so to plan the introduction of the 625-line standard in the VHF bands as to permit a gradual spread of the new standard throughout the country and a gradual close-down of the 405-line services. All 405-line services would have to be closed down before 625-line transmissions could be started in the same frequency bands.

26. In addition to the frequency planning problems, to make an overnight switchover of all the 405-line services would raise other problems. Although, since 1963, dual-standard receivers have been so made as to enable them to be modified to receive 625-line pictures in the VHF bands, these and all other existing receivers would require modification to a greater or lesser extent. Also, if the change in carrier frequency in any area were very great, further modifications would be required in the receivers and in many cases new aerials would be required. Thus considerable, and probably unrealisable, engineering effort would have to be marshalled to make these changes throughout the country within a very short time.

Problems of Duplication

27. To produce an exact replica in UHF of the VHF services is virtually an impossible task because of the differing propagation characteristics of VHF and UHF (discussed more fully in Appendix 5 which contains details of the national coverage attained by the present television services in VHF, together with outline plans of UHF coverage). VHF signals can be received satisfactorily much further from a transmitter than can UHF signals. Consequently people living at the edge of the present VHF service areas would have to receive their VHF and UHF service from transmitters at different sites. For this reason alone some places which are in the shadows of hills and hence get poor signals from one transmitter, may get good signals from the other and vice versa. Furthermore pockets of poor reception are much more pronounced at UHF, so that areas that have satisfactory VHF services may not be as well served by UHF.

28. There is also the problem of cost. Far more UHF stations than VHF stations are required to attain national coverage for a television service. The duplication of the existing network of VHF transmitting stations by a network of UHF stations would therefore be costly.

CONSIDERATION OF THE PROBLEMS

Overnight Switchover

29. The Committee recognised the attractions of a changeover in the VHF bands if some way could be found of overcoming the frequency planning and other problems. VHF with its favourable propagation characteristics offered the cheapest and easiest way of providing coverage of the whole population of the United Kingdom. Moreover, near-national coverage had already been attained by the existing services in the VHF bands.

30. The Committee therefore explored the possibility of extending the frequency space available in the VHF bands for television broadcasting. This was not, however, found to be a practicable proposition as the services operating on the adjacent bands could not be accommodated elsewhere in the frequency spectrum for many years. The need to make the changeover was urgent and the time-scale involved ruled out an extension of the frequency space available for broadcasting in the VHF bands as a means of making possible a changeover within the VHF bands.

31. The Committee also considered a proposal that the 625-line signals should be radiated in 5 MHz channels without changing the frequencies of transmission. Although tests showed that the quality of the picture displayed with the restricted channel width necessary for this operation was no worse than that of the 405-line picture, this method would not have allowed the introduction of colour and the proposal was not pursued.

32. A method of transmitting the sound by modulation of a pulse inserted in the video signal waveform was also tested. This would have saved the bandwidth at present used to transmit the sound signal but this method again would not have permitted colour to be transmitted within the present channel width of 5 MHz.

33. More fundamentally, the Committee concluded that no system based on the use of 5 MHz channelling in the VHF bands was acceptable, since it

was of prime importance to the viewer to have a receiver that was designed to receive a standard signal with the same characteristics of bandwidth and line definition both in UHF and VHF. It was therefore recommended that future planning should be on the basis of using 8 MHz channels in the VHF bands similar to those to be used in the UHF bands.

Duplication

34. The main disadvantage of duplication was that the propagation characteristics of UHF compared with VHF make it more difficult to secure adequate coverage on the former. However, the introduction of B.B.C.–2 on the 625-line standard in the UHF bands provided an opportunity to gain experience of UHF television as had been envisaged by the White Paper on Broadcasting (Cmnd. 1770, paragraph 44). The B.B.C.–2 programme has in the last few years become available to the majority of the population and experience has shown that where adequate aerials are used satisfactory coverage with UHF signals is possible.

35. The Committee noted, moreover, that any gaps in UHF coverage could be filled by the use of VHF stations on a limited scale, and by the extended use of wire relay systems. The coverage attained by television services in the UHF bands is expected to fall short of the present coverage attained in the VHF bands by B.B.C.–1 and the services of the Independent Television Authority. However, the UHF coverage could be supplemented by using a small number of stations operating on VHF and broadcasting on the 625-line standard in those areas where it was not possible, for technical reasons, to provide UHF stations. The immediate problem of television coverage must be solved by means of radiated signals; but in building up the coverage attained by the UHF services, it would be desirable to take full advantage of the use of communal aerials and wire relay systems in many areas of poor reception as an alternative to the proliferation of low-power broadcasting stations.

36. The other major problem of the duplication method is the expense involved. It had been agreed that the UHF network used for B.B.C.–2 should be planned as an integrated network to broadcast all four of the television programmes ultimately envisaged in the UHF bands. Nevertheless, it was clear that the provision of duplicate services from these UHF stations would be costly to the broadcasting authorities. On the other hand, there should be a very substantial benefit to the viewing public in the lower cost of a single-standard television receiver. The saving in the cost of television receivers was estimated to more than offset the additional costs of duplication to the broadcasting authorities even in the early years. Moreover, this saving would rise as the coverage attained by the duplicate services increased and with colour sets the advantages would be even more marked—the single-standard receiver should cost appreciably less as well as being more reliable in operation and less costly to maintain than dual-standard sets.

THE COMMITTEE'S RECOMMENDATION

37. These considerations led the Committee to conclude that only by the extensive use of the duplication method was there any prospect of changing the line standard within a foreseeable time. Nevertheless they recognised that the duplication method by itself could not, within the limits of what was

economically practicable, provide a complete answer. The Committee concluded that the process of changeover would need to make use both of the duplication method and of the overnight switchover method. They accordingly proposed that, in view of the urgency of the situation, the work necessary for duplication should be put in train at once and that the process should be continued until the number of people dependent on 405-line VHF reception was sufficiently small to make overnight switchover a manageable proposition. At that stage the overnight switchover from 405 lines to 625 lines in the VHF bands could be made for that residue of viewers. The 405-line transmissions in the VHF bands would then cease. There would thereafter be some continuing, though limited, use of the VHF bands on the 625-line standard to supplement the coverage of the programmes in UHF but a larger part of the frequency space in the VHF bands would become available for new 625-line television programmes. The decision, to make the overnight changeover, could be taken, in the light of progress with duplication, at any time after a period of obsolescence for existing 405-line only receivers (i.e. in seven to ten years' time).

38. There are four main advantages to the Committee's proposal. Firstly, it will enable the viewing public to receive all television services on the better line standard. Secondly, colour can be added to the duplicate 625-line B.B.C.–1 and I.T.A. services at the earliest possible moment giving much wider programme coverage in colour. Thirdly, as soon as all three television programmes are available on 625 lines in any area of the country, the viewers there, when they change their sets in the ordinary course of replacement, will be able to buy the single standard receivers which will give a better quality picture at a lower price than the existing dual-standard receivers. This advantage is even more marked in the case of colour receivers. Fourthly, concentration on the 625-line standard will improve export opportunities for United Kingdom manufacturers, not only because this standard is in general use throughout Europe and widely elsewhere, but because it will widen the domestic basis for the growth of colour television at a time when overseas television services will be turning towards colour.

Terms of recommendation to the Postmaster General

39. The full terms of our recommendation to the Postmaster General were as follows:—

Method of changing the line-definition standard

39.1. The first Memorandum on the Report of the Committee on Broadcasting, 1960 (Cmnd. 1770 July 1962) observed that it would be wrong to continue indefinitely to provide the services of television transmitted in the VHF Bands I and III on the technically inferior 405-line definition standard; and that in due course, therefore, these services should be changed over to 625 lines. In February 1963 the Postmaster General of the day invited our attention to the importance of establishing the method of changeover; and asked us to pursue studies, already in train, with a view to a recommendation on the method to be adopted. As one of the two main methods for consideration involved the use of UHF, it was understood from the outset that these studies would have to depend largely on the operational experience of UHF television to be provided by B.B.C.–2.

39.2. In March 1966 the Government decided, on the recommendation of the Committee, that a service of colour television, using the PAL transmission system and the 625-line definition standard, should be provided. As the recent White Paper on Broadcasting (Cmnd. 3169, December 1966) points out, the decision to provide colour television on the 625-line definition standard is closely related to the intention to change over the two 405-line services of B.B.C.–1 and independent television to 625 lines.

39.3. We have now completed our studies. In summary:

(i) They confirm the conclusion reached by the Committee in the Report published in May 1960 that overnight switchover (that is, the simultaneous changeover throughout the country from 405-line transmission and reception of the VHF services to 625-line transmission and reception, also in VHF) would be impracticable. Existing television sets would be incapable, without modification, of receiving the 625-line VHF transmission; and the task of modifying sets during the pre-switchover period would be unmanageable. Moreover, the increased bandwidth required to accommodate the superior standard would reduce the number of channels available, so that a reduction in total coverage would follow.

(ii) They show that complete duplication (that is, the reproduction in UHF and on 625 lines of a precise replica of the coverage attained by the present 405-line services in VHF) is unlikely to be achieved.

(iii) They lead us to conclude, however, that the most practicable method of advancing towards the declared objective of a single line standard—625 lines—for all United Kingdom television is to start upon a controlled process of duplication such that, after it had proceeded far enough, changeover could be completed by an overnight switchover in VHF. By this means increasing experience in UHF would be gained and the duplicate services would be extended to cover the majority of viewers, thereby minimising the number that would be affected by an overnight switchover.

39.4. We therefore recommend that:

(i) an early decision should be taken to adopt the duplication method to set the process of changeover in train;

(ii) colour programmes should be broadcast in the 625-line duplicates of the present 405-line services; and

(iii) the process should be timed to start at an early date.

From that date single standard monochrome and single standard colour receivers could be sold in areas where all television programmes were broadcast on the 625-line standard, so that cheaper and more efficient sets would be available to the viewing public.

39.5. More generally, the need to provide a single-standard 625-line set for the domestic market should enable manufacturers to compete more readily in overseas markets, since most other countries use the 625-line standard. For the capital goods side of industry, the export of cameras and studio equipment should also be facilitated.

39.6. In order that the advantages of transmitting all television services on a single standard should be realised as soon as possible, it is desirable that the duplicate programmes should spread quickly; and that the duplication of the B.B.C.'s and the I.T.A.'s 405-line services should so far as possible proceed together. As soon as the coverage attained by B.B.C.–2 (already transmitted on 625 lines and in UHF) has been matched by that of the duplicate programmes, the coverage of all three services should thereafter be extended simultaneously.

39.7. We recommend that duplication of the B.B.C.'s and the I.T.A.'s services should start at the same time. Given a decision now to authorise an early start to duplicating the B.B.C.'s and I.T.A.'s 405-line services, then the broadcasting authorities could be ready to start duplication towards the end of 1969 in London, the Midlands and the North. Initially the coverage attained by the duplicate services would be of the order of 45 per cent. of the total population of the country rising to about three-quarters by the end of 1971. As they develop, the B.B.C.'s and I.T.A.'s plans for the further spread of their duplicate services may differ in detail. The eventual development of the programme for extending duplication would be a matter for continuing consultation.

39.8. It is not part of our task to study the financial implications in detail. We understand that Post Office officials will undertake this, and will obtain from the broadcasting authorities estimates of the cost to them of changeover. We note that though the broadcasting organisations would be put to additional expenditure, to offset this there should be a very substantial benefit to the national economy as well as to the viewing public, in the lower cost of a single standard set.

39.9. We recommend also that the transmission standard to be used in the VHF bands, when re-engineered for 625 lines shall be precisely the same as that used in the UHF bands (C.C.I.R. Standard I). This would enable receiver manufacturers to ensure that all single-standard 625-line receivers, initially receiving only in the UHF bands would, without modification, also be capable of receiving 625-line signals in VHF when the VHF bands are re-engineered. The possible future extent of the broadcasting bands (see paragraph 12) should be clearly defined at the outset, so that manufacturers can make full provisions for the reception of all possible transmissions.

39.10. A decision on the date for the introduction of 625-line transmission in the VHF bands, and the use to which these bands will be put, should be deferred for a number of years during which the progress of duplication would be observed. In any case the close-down of 405-line services could not start for at least seven years to allow time for single-standard 405-line receivers to become obsolete. The Committee would not consider it acceptable to close down any of the existing 405-line transmissions in VHF if this involved a reduction of any significance in the population coverage attained by B.B.C.–1 and independent television.

39.11. Further extensions of the coverage attained by, and improvements to the reception of, existing VHF services would increase the difficulty of the eventual changeover from 405 to 625 lines. Hence on technical grounds we recommend that further extension of VHF 405-line broadcast services should be stopped, except for those new stations now planned or where a special need can be shown to exist.

39.12. We wish to draw attention to the fact that, whatever pattern of frequency allocation is adopted, the ultimate objective of six services of national coverage (two in VHF and four in UHF) will be jeopardised unless additional channels for broadcasting can be made available above 216 MHz in VHF and above 854 MHz in UHF. These would not be required for use until the 1970's, the precise date being dependent upon the rate of introducing new services. Nevertheless, for frequency planning purposes, an early indication of how far these bands might be extended is important and we recommend that the possibility of securing additional channels be re-examined.

Appendix 1

Terms of Reference

To advise the Postmaster General on the development of television and sound broadcasting at frequencies above 30 Megahertz and related matters, including competitive television services and television for public showing in cinemas and elsewhere.

Composition of Television Advisory Committee

Chairman	The Lord Jackson of Burnley, D.Sc., C.Eng., F.R.S.
Independent Members ...	The Lord Aberconway Sir Rex Cohen, K.B.E. Mr. Roger Falk, O.B.E.
Radio Industry	Mr. Dudley Saward, O.B.E. Mr. C. O. Stanley, C.B.E. Mr. F. N. Sutherland, C.B.E.
B.B.C.	Sir Hugh Greene, K.C.M.G., O.B.E.
I.T.A.	Sir Robert Fraser, O.B.E.
Treasury	Mr. L. Petch (until February 1965) Mr. F. R. P. Vinter, C.B. (from February 1965)
*Ministry of Technology ...	Mr. J. Leckie (until November 1965) Mr. I. Maddock, C.B., O.B.E., F.R.S. (from November 1965)
Post Office	Mr. A. Wolstencroft, C.B. (until August 1964) Mr. H. G. Lillicrap (from August 1964)
Secretary (Post Office) ...	Mr. J. L. Judd (until August 1964) Mr. J. V. R. Birchall (August 1964 to July 1966) Mr. D. T. Tudge (from July 1966)

*The Ministry of Technology assumed responsibility for sponsoring the electronics industry in place of the Ministry of Aviation, which had been represented on the Committee by Mr. D. W. G. L. Haviland, C.B.

APPENDIX 2

Composition of Technical Sub-Committee during the period 1960-1967

Chairman	Sir Albert Mumford, C.B.E., B.Sc., C.Eng., F.I.E.E., General Post Office (February 1960—February 1965) Mr. D. A. Barron, C.B.E., M.Sc., C.Eng., F.I.E.E., General Post Office (February 1965—April 1967) Mr. J. H. H. Merriman, O.B.E., M.Sc., A.Inst.P., C.Eng., F.I.E.E., General Post Office (from April 1967)
Deputy Chairman ...	Sir Harold Bishop, C.B.E., C.Eng., M.I.Mech.E., F.I.E.E., British Broadcasting Corporation (December 1962—May 1963) Sir Francis McLean, C.B.E., B.Sc., C.Eng., F.I.E.E., F.I.E.E.E., British Broadcasting Corporation (from May 1963)
Post Office	Capt. C. F. Booth, C.B.E., C.Eng., F.I.E.E. (until March 1963) Mr. J. H. H. Merriman, O.B.E., M.Sc., A.Inst.P., C.Eng., F.I.E.E. (March 1963—April 1965) Mr. H. Stanesby, C.Eng., F.I.E.E. (from April 1965) Mr. T. Kilvington, B.Sc. (Eng.), C.Eng., F.I.E.E., F.R.T.S. (since relinquishing the post of Secretary in May 1963)
B.B.C.	Dr. R. D. A. Maurice, Dr. Ing. Ing.,E.S.E., C.Eng., F.I.E.E., F.R.T.S.
I.T.A.	Mr. P. A. T. Bevan, C.B.E., B.Sc., C.Eng., F.I.E.E. Mr. F. H. Steele, B.Sc. (Eng.), A.C.G.I., C.Eng., M.I.E.E. (from July 1966)
I.T.C.A.	Mr. T. C. Macnamara, O.B.E., C.Eng., M.I.E.E.
Radio Industry	Dr. A. J. Biggs, Ph.D., B.Sc., C.Eng., F.I.E.E., General Electric Company (from October 1965) Dr. L. F. Broadway, O.B.E., Ph.D., B.Sc., C.Eng., F.I.E.E., Electric and Musical Industries. Mr. V. J. Cooper, B.Sc., A.C.G.I., C.Eng., M.I.E.E., M.I.R.E., M.I.E.E.E., Marconi Wireless Telegraph Co. Ltd. (until his decease in March 1967) Mr. K. I. Jones, O.B.E., A.M.I.E.E., British Radio Corporation Ltd. Mr. E. P. Wethey, B.Sc., Kolster-Brandes Ltd. (until October 1965)
Relay Services Association	Mr. R. P. Gabriel, B.Sc., C.Eng., F.I.E.E., M.I.E.E.E., Rediffusion Ltd. (from March 1966)
Others	Dr. R. L. Smith-Rose, C.B.E., D.Sc., Ph.D., C.Eng., F.I.E.E. Mr. T. M. C. Lance, A.C.G.I., British Film Producers Association

The Government Department responsible for sponsoring the electronics industry sends an observer who, from April 1965, was Mr. R. A. Neate of the Ministry of Technology.

Secretary	Mr. C. W. Sowton, O.B.E., B.Sc. (Eng.), A.C.G.I., C.Eng., M.I.E.E. (until September 1961) Mr. T. Kilvington, B.Sc. (Eng.), C. Eng., F.I.E.E., F.R.T.S. (September 1961—May 1963) Mr. C. E. E. Clinch, B.Sc. (Eng.), C.Eng., F.I.E.E., F.S.S. (since May 1963)

APPENDIX 3

Choice of a colour television system

1. There were three major colour television systems to be considered by the Committee:

NTSC (National Television Systems Committee), an American system;

SECAM (Sequential a Memoire), a French system; and

PAL (Phase Alternation Line), a German variation of the NTSC system.

The Committee, with the aid of its Technical Sub-Committee, concluded that the United Kingdom ought to adopt the PAL system.

2. The SECAM system was modified in detail on a number of occasions and after study of the system named SECAM III A which had the optimised parameters, the Technical Sub-Committee reported in October 1965. The full terms of the Report are annexed.

3. The Committee concluded that the disadvantages of the SECAM system clearly outweighed the advantages and accordingly rejected the system for use in the United Kingdom.

4. The technical factors affecting the choice between NTSC and PAL were fairly evenly balanced. Although the PAL compatible monochrome picture is of slightly poorer quality than that of NTSC, it is of an acceptable standard. Equally, the slight loss of colour picture detail inherent in the PAL system is so small as to be unlikely to be noticeable to the viewing public. The PAL signal is more tolerant than that of NTSC to some forms of distortion arising in the multiplicity of equipment necessary for colour television. In addition, the colour errors caused by reflected signals in mountainous country, and in urban areas where there are tall buildings, are less troublesome with the PAL system. The slightly higher cost of receivers is offset by reduced maintenance costs and simplified receiver operation. In short, the use of the PAL system should ensure the reception of good quality colour pictures in the home.

5. Apart from the strictly technical factors there was also the problem of trying to reach agreement on a common colour system for Europe. NTSC was unlikely to be acceptable and the problem at the XIth Plenary Assembly of the International Radio Consultative Committee, to be held in June 1966, at Oslo, was seen to be likely to resolve itself into a choice between PAL and SECAM for most European countries. This assessment, which was confirmed by the events of the Conference, settled the Committee in favour of the PAL system.

6. Accordingly in December 1965 the Committee unanimously recommended to the Postmaster General that the United Kingdom should adopt the PAL system of colour television. The Postmaster General accepted the recommendation and announced the Government decision in the House on the 3rd March 1966. The announcement included the proviso that if the Oslo Conference in June 1966 were to show that another system, against general expectations, found general acceptance the United Kingdom would naturally take that into consideration. The Committee had added a proviso to its Report that if unanimous agreement on any standardised system could be reached at Oslo by European countries, the United Kingdom should be prepared to join in. This proviso had been added in the interests of international co-operation. In the event, no common system was, however, agreed to at Oslo and so the United Kingdom adopted the PAL system of colour television. Colour television was launched on the B.B.C.–2 service on 1st July 1967 and the full colour service on B.B.C.–2 began on 2nd December 1967.

APPENDIX 3

Annex

Report by Technical Sub-Committee

Choice of colour system for the 625-line standard

Since the report made to the T.A.C. in May 1965 (C.P. 363) the Technical Sub-Committee have given thought to SECAM IIIA now proposed by France and reviewed their previous advice and have reached the following unanimous conclusions:

(i) We still reject SECAM because:

(*a*) the SECAM signal contains less colour information than the other two standards and as a corollorary there is significant loss of vertical colour definition;

(*b*) the mixing of AM and FM signals within the vision signal causes complexity in the receiver;

(*c*) the signal is less suitable for single gun picture display devices;

(*d*) its proponents state that the parameters now chosen give the best possible performance and therefore there is no room for further development of the transmitted signal.

(ii) The technical factors affecting the choice between NTSC and PAL are fairly evenly balanced. The main limitations of these two systems are as follows:

(*a*) *Limitations to be accepted if NTSC is chosen*

(i) The Broadcasting Authorities and the Post Office would have to operate their equipment and lines within closer but practicable tolerances.

(ii) In some areas where strong multi-path interference is encountered, the picture quality obtained with NTSC could be slightly worse than with PAL.

(iii) NTSC is less likely to be accepted in Europe than is PAL; thus the programme interchange between Europe and the U.K. would possibly become more complicated and the export of complete television receivers would be handicapped.

(iv) The easier tolerances in the manufacture, installation and maintenance of receivers, and improvements in colour stability permitted by PAL, would be lost.

(*b*) *Limitations to be accepted if PAL is chosen*

(i) Tests of compatibility using a scale of subjective impairment to picture quality suggest that the number of unfavourable opinions due to sub-carrier pattern with NTSC may be half the number with PAL. In neither case, however, is there likely to be a significant number of complaints, especially bearing in mind that sub-carrier pattern would be only one of a number of impairments arising in everyday broadcasting. BREMA have agreed that they will arrange that the response at the sub-carrier frequency in their new monochrome receivers will be acceptable to the public and that on existing receivers, dealers can carry out, if necessary, a simple modification.

(ii) With receivers designed to take the full advantages of the PAL system there would be a small inherent loss of picture colour detail but this is unlikely to be noticeable to the public.

(iii) Receiver costs to the public would be higher by 3.5 to 4 per cent but some of this would be offset by lower maintenance costs.

(iv) PAL is unlikely to be used in America or in countries in her field of influence and this will make programme exchange with these countries slightly more difficult.

From the above assessment, the TAC/TSC considers that neither of the two possible systems has a complete advantage over the other but agrees that the following are the most important points:

(i) From the point of view of programme origination, recording and distribution, and for receiving, PAL would in most respects present the easier problem to the people concerned, although the problem for NTSC is readily soluble.

(ii) The compatible picture obtained with PAL is on average slightly worse than that obtained with NTSC but the number of complaints likely to arise is insignificant, and BREMA are satisfied that they can deal satisfactorily with this problem.

APPENDIX 4

Comparison of 405-line and 625-line standards
Situation in 1967

Line Standard	405	625
Programmes Transmitted	B.B.C.-1 and I.T.A.	B.B.C.-2
Frequency bands used	Bands I and III	Bands IV and V
Sound modulation	Amplitude	Frequency
Sense of vision modulation	Positive	Negative
Vestigial sideband width	0·75 MHz	1·25 MHz
Full Sideband transmitted	lower	upper
Nominal Video bandwidth	3 MHz	5·5 MHz
RF Channel width	5 MHz	8 MHz
Sound to Vision carrier spacing	3·5 MHz	6 MHz
Colour sub-carrier	nil	4·43 MHz

Further details are given in CCIR Report 308–1 and Report 407, Documents of the XIth Plenary Assembly, Oslo, 1966, Vol. V.

Appendix 5

Frequency bands allocated to television broadcasting in the United Kingdom

1. The frequency spectrum at present available for television broadcasting in the United Kingdom is as follows:

	Band	*Frequency*	*405–line channels*	*625–line channels*
VHF	I	41–68 MHz	5 channels 5 MHz wide	3 channels 8 MHz wide
	III	174–216 „	8 channels 5 MHz wide	5 channels 8 MHz wide
UHF	IV	470–582 „		14 channels 8 MHz wide
	V	614–854 „		30 channels 8 MHz wide

Very High Frequency Bands

2. *Band I* at the end of 1967 eighty-two stations were already broadcasting B.B.C.–1 on 405 lines in this band and another twenty-four were planned. The coverage attained by B.B.C.–1 from these stations and the eight stations operating in Band III is over 99 per cent. of the population of the United Kingdom. Map 1 shows the coverage at 31st December 1967. The additional lower power stations now being planned will not materially affect the total percentage coverage figure.

3. Because, under certain atmospheric conditions which may arise for prolonged periods during several summer months, interference is caused by distant continental stations, the usefulness of Band I is impaired for monochrome television reception and would be even more impaired if colour were to be transmitted. This interference will increase as the number and power of continental television stations increases, and will also impair the usefulness of this band for 625-line transmissions in the future. The Technical Sub-Committee made a study of this problem, and its report is annexed.

4. *Band III*—At the end of 1967 thirty-one stations were already broadcasting the services of the I.T.A.; another twelve stations were in various stages of construction, and a further five were in the early planning stages. The coverage attained by the I.T.A. services on the 405-line standard is about 98 per cent. of the population of the United Kingdom. Map 2 shows the coverage at 31st December 1967. Additional low-power stations now being built will not materially affect the total percentage coverage figures.

Ultra-High Frequency Bands

5. There is estimated to be room in the UHF bands for four television services of near national coverage. The coverage which they will attain will be unequal but, on the latest planning standards, for three of them it should be of the order of 95 per cent. The coverage attained by the fourth service will probably be somewhat less. At present, one service, B.B.C.–2, is being broadcast on 625 lines. Twenty-four was the total number of main and relay stations in service at the 31st December 1967, when B.B.C.–2 had attained a coverage of approaching 70 per cent. of the population of the United Kingdom. Plans already authorised by the Postmaster General should increase the number of main stations to forty-four, and extend the coverage to some 90 per cent. of the population by mid-1974. Map 3 shows the coverage at 31st December 1967 and the estimated coverage by mid-1974.

6. The three other possible services in the UHF bands will use the same network of stations already provided by the B.B.C. and the I.T.A. for B.B.C.–2. The duplicate 625-line services of B.B.C.–1 and independent television proposed by the Committee

are those being planned on the basis of using existing UHF stations. Plans now approved by the Postmaster General already envisage the duplicate services attaining 75 per cent. coverage of the United Kingdom population by the end of 1971. Map 4 shows the estimated coverage by the end of 1971.

7. During the period of the duplication of the B.B.C.–1 and I.T.A. services, there will still be room in the UHF bands for the provision of a fourth television service if required, although the coverage it would attain might be less than that of any of the other three UHF services.

Technical reasons for disparity of coverage in VHF and UHF

8. The planning of a television service to attain near national coverage is highly complex, requiring engineering judgment to make the optimum selection of transmitter powers, aerial configurations, mast heights and other technical characteristics of the stations. The planning also has to be greatly influenced by practical considerations such as the availability of sites and power supplies, road access, etc. The signal level picked up by a receiving aerial with a similar number of elements is very much less at UHF than at VHF, and this discrepancy cannot be made up by using larger transmitting and receiving aerials, or higher transmitter powers. Hence UHF transmitting stations have to be closer together than VHF stations. The fact is illustrated above in that Band I provides near national coverage for B.B.C.–1 with twenty main stations and ninety low power relay stations whereas in UHF over sixty main stations, two hundred major relay stations and seven hundred low power relay stations are expected to be required to provide the same coverage. Thus, some people receive their VHF and UHF services from different stations and consequently have to have their VHF and UHF aerials pointing in different directions.

9. Moreover, the higher the frequency the worse are the pockets of poor reception in the shadows caused by buildings and in hollows. Consequently viewers living in a hollow may have a poor VHF signal but a completely unacceptable UHF signal even if both are radiated from the same transmitting station.

10. UHF transmission does, however, possess certain advantages. It is not affected by Sporadic E interference (see Annex) or ignition interference from cars. The more highly directional aerials used reduce the number of ghost images caused by reflection of the television signal and also the flutter caused by reflections from aircraft.

APPENDIX 5

Annex

Report by Technical Sub-Committee

Long-distonce Interference to Television Reception

1. On Wednesday 12th October 1966 the B.B.C. demonstrated at video frequency the effects of a particular type of interference (that from distant stations occupying the same wave-band) on a 405-line television picture. This demonstration showed that interference that was just tolerable to a viewer of a monochrome signal could become very serious when a colour signal was radiated, regardless of whether the viewer used a colour or monochrome receiver.

2. This increase of interference with colour transmissions will arise only in the VHF bands because of the variety of channelling plans adopted in Europe in these bands. In UHF, because a uniform channelling plan based on 625-line standards has been adopted throughout Europe, no troubles of this nature should arise. Should this uniformity be disturbed, a serious interference problem would then arise in UHF too.

3. Interference from distant stations can be of two kinds:—

(o) " Tropospheric " interference, which occurs by day or night in Bands I and III. It arises only from relatively nearby countries, and can be allowed for in the planning of frequency assignments. This was, in fact, done in planning the 405-line VHF services but only in so far as monochrome signals are concerned.

(b) " Sporadic E " ionospheric interference, which varies considerably in duration and intensity year by year, occurs normally in daylight hours during the summer months, affecting Band I only. Very strong interfering signals can be received from transmitters about 700 to 1,200 miles away. At the VHF European Planning Conference, Stockholm, 1952, it proved to be impracticable to allow for this type of interference in planning. This form of interference may be active for as much as 5 per cent. of the time during the summer months and tends to be concentrated in periods of 1–4 days duration particularly in the areas served by the lower channels of Band I. As more transmitters continue to come into service on the Continent this form of interference will increase.

4. The extent to which interference would affect the viewing of monochrome pictures if colour were to be introduced into the existing VHF services is summarised in the following paragraphs:—

4.1. If colour were added to the existing 405-line service there would be an increase in the visibility of interference due to " Sporadic E" effects in the B.B.C.–1 service particularly on Channels 2, 3 and 4 and it has been estimated that during active periods interference would be increased for about nine million people. The subjective effect of this interference varies with the frequency difference between the interfering signal and the colour sub-carrier, the quality of the receiver and its tuning, and the field strength of the wanted programme. Tests on domestic receivers with the kind of interference usual in Channel 2 have shown that, for equivalent subjective effects, the field strength that needs to be protected in the presence of a colour sub-carrier has to be increased by about 11 db. It is estimated that a similar increase will be needed on the other affected channels.

4.2. The introduction of a colour sub-carrier will also increase the field strength required for an acceptable service in the presence of tropospheric interference. The increase in the field strength that should be protected will be the same order as for " Sporadic E " interferenee. However, the number of viewers affected will be considerably lower because the aress concerned are mainly only those in S.E. England.

4.3. For a substantial proportion of viewers it would be possible to reduce the interference to tolerable proportions for monochrome reception by fitting a filter at each receiver installation to reject the colour signal or other nearby frequencies, but to equip some three million receivers in this way would be an expense which may not readily be accepted by viewers continuing to rely on monochrome reception. A filter can also be used to eliminate much of the interference on some channels to colour reception although in this case the filter must have a better and more stable performance than for monochrome reception.

4.4. Continental stations would suffer similar increases in interference on the addition of colour to their transmissions but while the overall effect would be of the same order of magnitude, the detailed pattern of interference would not be precisely reciprocated. The addition of colour only to the interference service would significantly change the level of the interference now suffered only in a few cases.

5. The extent to which the interference would affect the viewing either in monochrome or colour of any 625-line transmission in the VHF bands is summarised in the following paragraphs:—

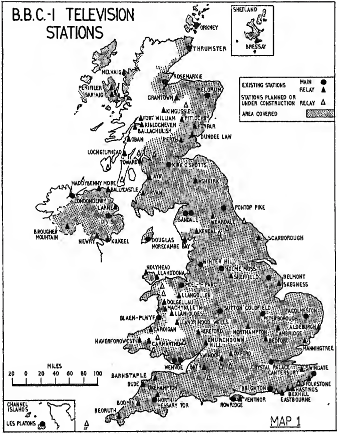
5.1. In the process of rearranging the VHF bands for 625-line transmission it would be possible to allow, in a considerable degree, for the effects of tropospheric interference on colour signals for both colour and monochrome viewing. Thus the interference in Band III would be very similar for colour on 625 lines as for monochrome 405 lines.

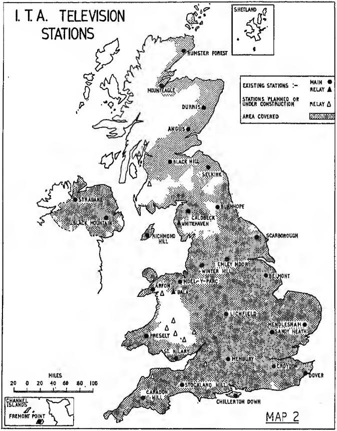
5.2. In replanning Band I it would be difficult to mitigate the effect of " Sporadic E " interference, and this is the major source of trouble in this band. A proposal by the B.B.C. to use " inverted " channels in Band I might lead to a reduction in the effect of " Sporadic E" interference but would complicate receiver design and lead to new problems of interference with Irish and Continental stations, which have not yet been studied. Without the use of " inverted " channels it is unlikely that the position would be any better with 625-line transmission than it is with 405-line, unless the VHF service is supplemented by the use of UHF to a greater extent or more channels above Band III are made available.

6. *Conclusion*

6.1. The addition of colour to the existing 405-line services would seriously increase the incidence of interference from distant stations. For some viewers this could be mitigated by the fitting of filters.

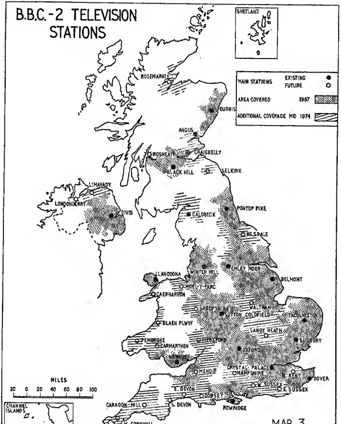
6.2. The replanning of the VHF bands for 625-line operation with colour would be an opportunity to reduce the effects of tropospheric interference. To make any significant reduction in the effect of " Sporadic E " interference the use of channels in Band I would have to be confined to fill-in purposes and increased use would have to be made of UHF channels above Band III for main coverage.


B.B.C.-1 TELEVISION STATIONS
SHETLAND
BRESSAY
ORKNEY
THRUMSTER
MELVAIG
ROSEMARKIE
PENIFILER
SKRIAIG
GRANTOWN
MELDRUM
EXISTING STATIONS MAIN ●
RELAY ▲
STATIONS PLANNED OR UNDER CONSTRUCTION RELAY △
AREA COVERED ▨
KINGUSSIE
FORT WILLIAM
PITLOCHRY
KINLOCHEVEN
BALLACHULISH
FORFAR
OBAN
PERTH
DUNDEE LAW
LOCHGILPHEAD
TOWARD
KIRK O'SHOTTS
AYR
ASHKIRK
MADDYBENNY MORE
BALLYCASTLE
GIRVAN
LONDONDERRY
LARNE
PONTOP PIKE
SANDALE
WEARDALE
DIVIS
BROUGHER MOUNTAIN
KENDAL
NEWRY
KILKEEL
DOUGLAS
MORECAMBE BAY
SCARBOROUGH
WINTER HILL
HOLYHEAD
HOLME MOSS
LLANDDONA
SHEFFIELD
BELMONT
MOEL-Y-PARC
SKEGNESS
LLANGOLLEN
DOLGELLAU
MACHYNLLETH
SUTTON COLDFIELD
TACOLNESTON
LLANIDLOES
PETERBOROUGH
BLAEN-PLWYF
LLANDRINDOD WELLS
ALDEBURGH
CARDIGAN
HEREFORD
NORTHAMPTON
CAMBRIDGE
HAVERFORDWEST
CARMARTHEN
CHURCHDOWN HILL
BEDFORD
MANNINGTREE
SWINDON
OXFORD
MILES
20 0 20 40 60 80 100
WENVOE
BATH
CRYSTAL PALACE
SWINGATE
BARNSTAPLE
CANTERBURY
BUDE
OKEHAMPTON
FOLKSTONE
HASTINGS
BEXHILL
BRIGHTON
BODMIN
NORTH HESSARY TOR
VENTNOR
EASTBOURNE
ROWRIDGE
CHANNEL ISLANDS
REDRUTH
LES PLATONS
MAP 1

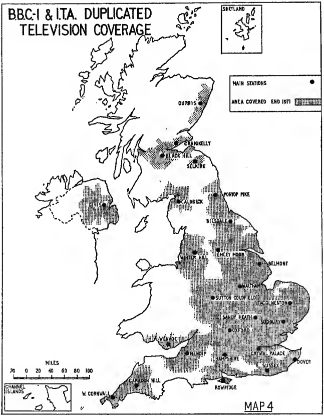


I. T. A. TELEVISION STATIONS

MAP 2


B.B.C.-2 TELEVISION STATIONS
SHETLAND
MAIN STATIONS
EXISTING ●
FUTURE ○
AREA COVERED 1967
ADDITIONAL COVERAGE MID 1974
ROSEMARKIE
DURRIS
ANGUS
ROSNEATH
CRAIGKELLY
BLACK HILL
SELKIRK
LIMAVADY
LONDONDERRY
DIVIS
CALDBECK
PONTOP PIKE
BILSDALE
LLANDDONA
WINTER HILL
EMLEY MOOR
BELMONT
MOEL-Y-PARC
CAERNARVON
SHROPSHIRE
WALTHAM
SUTTON COLDFIELD
TACOLNESTON
BLAEN PLWYF
SANDY HEATH
PEMBROKE
CARMARTHEN
HEREFORD
SUDBURY
OXFORD
WENVOE
MENDIP
CRYSTAL PALACE
HAMPSHIRE
N. KENT
DOVER
W. SUSSEX
E. SUSSEX
E. DEVON
DORSET
CARADON HILL
S. DEVON
ROWRIDGE
W. CORNWALL
MILES
20 0 20 40 60 80 100
CHANNEL ISLANDS

MAP 3



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